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(56) Documents Cited
US 4709591 A US 4479400 A US 4428450 A
US 4187736 A US 3951045 A

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(54) Electric power steering system with impact absorbing means

(57) Impact absorbing means, eg plate spring 130, is provided between the rack housing 110 and the output shaft 112a so as to be pressed and deformed between the housing and the output shaft at the end of the reciprocating motion of the output shaft. The plate spring 130 is limited axially by an annular rubber member 131 and acts against a metal stopper ring 132. Thus, even when the electric motor rotates at a high speed toward the end of the reciprocating stroke of the output shaft, the impact force generated at the arrival of the output shaft at the end of the stroke can be sufficiently absorbed by the deformation of the impact absorbing means, so that the deterioration in the function of the power transmission system can be prevented.

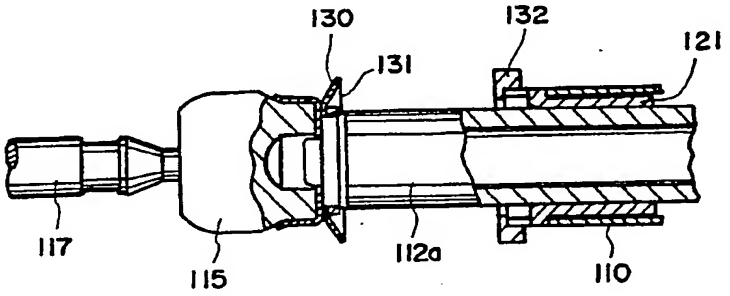

FIG. 2

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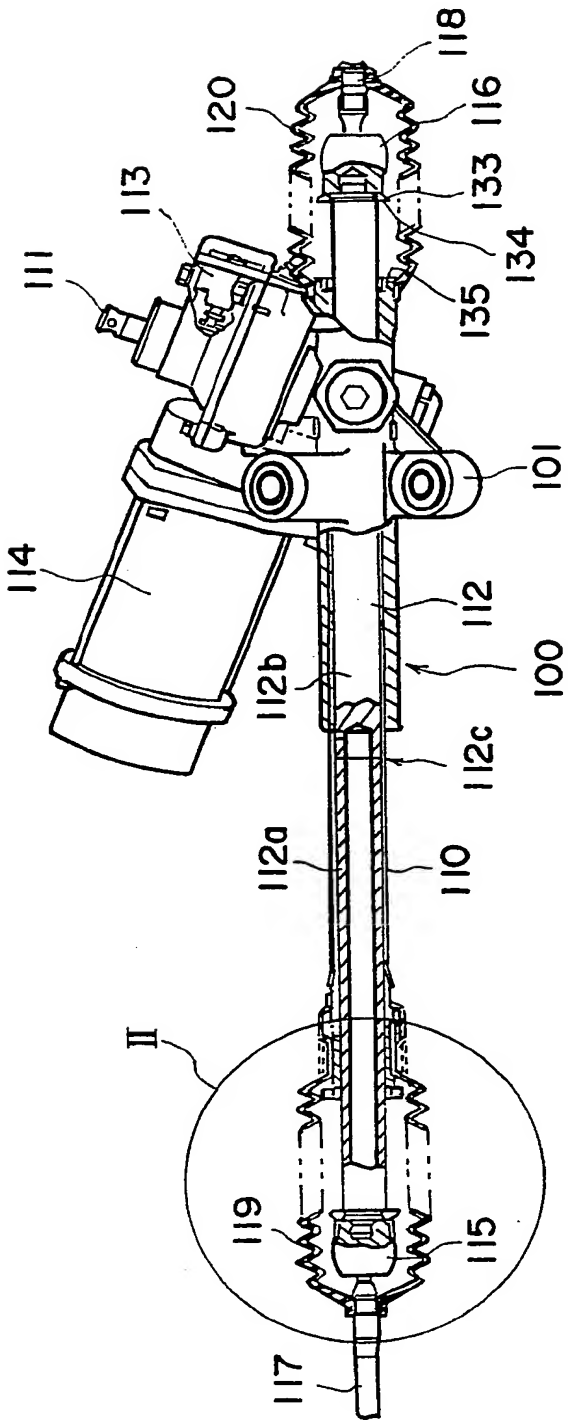

FIG. 1

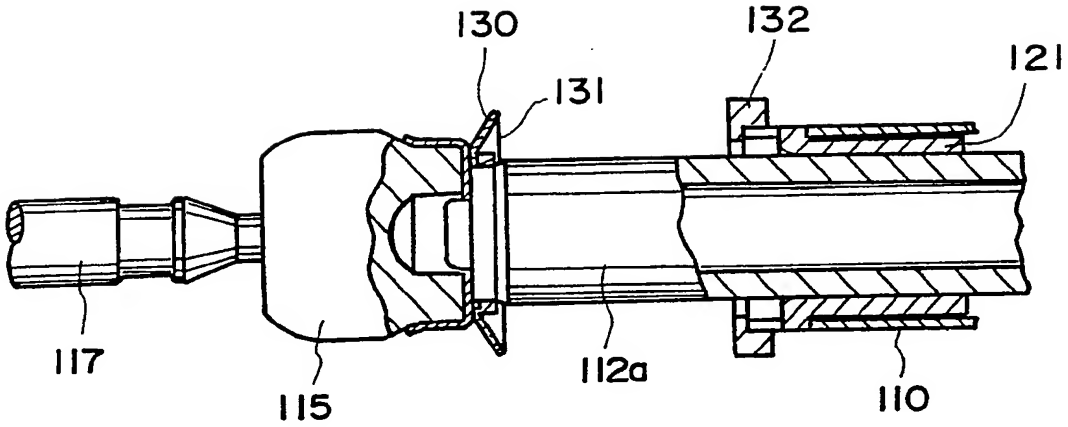

FIG. 2

ELECTRIC POWER STEERING DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an electric power steering device.

Related Background Art

As an electric power steering device for a vehicle, there is already known a device in which the rotary output of an electric motor, providing the auxiliary steering torque, is transmitted to an output shaft of a steering mechanism after velocity reduction in a gear device, and is used to assist the manual force applied to a steering wheel in reciprocating said output shaft in a predetermined range, thereby steering the wheels of the vehicle. In the course of function of such electric power steering device, there may result various impact forces, which may deteriorate the function of the electric motor and the power transmission mechanisms.

For relaxing or resolving such impact forces, there is conventionally employed, for example:

1. a method of providing the output shaft of the steering mechanism with a slip mechanism utilizing frictional force and serving as a torque limiter which generates slippage under an excessively high torque (as disclosed in the Japanese Utility Model Laid-Open Application No. 6-39664); or

2. a method of providing the rotary shaft with an electromagnetic clutch serving as a torque limiter.

In such conventional electric power steering device, either of the above-mentioned methods is effective for relaxing the impact force received from the road face in any situation, but a less expensive configuration is desired as they are both expensive in cost. On the other hand, it is found out that the impact force resulting from the inertia of the electric motor in the reducing mechanism of the electric power steering device tends to be generated particularly when the output shaft comes in contact with the stopper at the stroke end, for example when a wheel rides on a curbstone while the output shaft is close to the stroke end, or when the wheel are steered at a high speed during the maintenance work of the vehicle. Stated differently, the expensive configuration in the prior art can be almost dispensed with if the sudden stoppage of the output shaft during high-speed movement, resulting from the contact with the stopper at the stroke end, can be prevented.

SUMMARY OF THE INVENTION

The object of the present invention is to provide an electric power steering device capable of preventing the deterioration in the function of the electric motor and the power transmission system with a simple

configuration.

The above-mentioned object can be attained, according to the present invention, by an electric power steering device provided with;

a housing;

a motor mounted on said housing and having a rotary shaft;

an output shaft for steering wheels, capable of reciprocating motion within a range limited by said housing;

an input shaft connected to a steering wheel; and

power transmission means connecting said input shaft and said output shaft, and adapted to receive an auxiliary steering force from the rotary shaft of said motor;

wherein said electric steering device comprises impact absorbing means provided between said housing and said output shaft, and adapted to be pressed and deformed between said housing and said output shaft at an end of the reciprocating motion of said output shaft, thereby absorbing the impact force generated when said output shaft reaches the end of the reciprocating motion in a high-speed movement.

In the electric power steering device of the present invention, because of the presence of the impact absorbing means between said housing and said output shaft and adapted to be pressed and deformed

between said housing and said output shaft at the end of the reciprocating motion of said output shaft, the deterioration in the function of the power transmission system can be prevented even in case the electric motor rotates at a high speed toward the end of the reciprocating motion of the output shaft, as the impact force generated on the output shaft upon arrival at the end of the reciprocating motion can be sufficiently absorbed by the deformation of the impact absorbing means.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially cut-off lateral view of an electric power steering device 100 constituting an embodiment of the present invention; and

Fig. 2 is a magnified view of a part II of the electric power steering device shown in Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following there will be given a detailed explanation of an embodiment of the present invention, with reference to the attached drawings.

Fig. 1 is a partially cut-off lateral view of an electric power steering device 100 constituting an embodiment of the present invention.

Referring to Fig. 1, the electric power steering device 100 is provided with a housing body 101 and a

rack column 110 extending therefrom. The housing body 101 and the rack column 110 are fixed to an unrepresented vehicle body by unrepresented brackets, and integrally constitute a housing. Inside the housing body 101, there extends, in inclined manner from above, an input shaft 111 of which an end is to be connected to a steering shaft and a steering wheel (not shown). Also inside the housing body 101 and the rack column 110, there extends a rack shaft 112 constituting an output shaft. The input shaft 111 is provided, at the lower end thereof, with an unrepresented pinion which meshes with a rack formed on the rack shaft 112, whereby the rack shaft 112 moves laterally by the rotation of the input shaft 112. The rack shaft 112 consists of a hollow shaft 112a and a solid shaft 112b bearing a rack on the external periphery, mutually connected by a welded portion 112c.

A torque detecting device 113 is provided in the housing body 101. Said torque detecting device 113 is designed to detect the torque applied to the input shaft 111 by means of a torsion bar and to release a corresponding signal. The structure of such device is already well known and will not, therefore, be explained further.

Also in the housing body 101 provided is reducing means (for example bevel gear mechanism) which is linked with the input shaft 111, for transmitting the

power from the rotary shaft (not shown) of an electric motor 114, provided on the housing body 101, to the input shaft 111 after speed reduction. The torque detecting device 113 and the electric motor 114 are connected to an unrepresented control device.

The rack shaft 112 is provided, on both ends thereof, with ball joints 115, 116 which are respectively articulated to ends of tie rods 117, 118. Around the ball joints 115, 116 there are provided boots 119, 120 for dust prevention.

Fig. 2 is a magnified view of a part II of the electric power steering device shown in Fig. 1. Referring to Fig. 2, in the vicinity of the end of the rack column 110, there is provided a rack bushing 121 constituting a slip bearing and serving to support the hollow shaft 112a of the rack shaft 112, axially movably with respect to the rack column 110. At the end of the rack column 110 there is mounted a stopper 132, consisting of a metal ring, for example by shrinkage fitting. Also at the end of the hollow shaft 112a adjacent to the ball joint 115, a troncoconical plate spring 130 is fitted so as to oppose to the stopper 132. The plate spring 130 is limited, in its axial movement, by an annular rubber member 131.

As shown in Fig. 1, a plate spring 133 and a rubber member 134 are similar provided in the vicinity of the right ball joint 116, but a stopper 135 opposing

thereto is substantially hat-shaped and is fitted in the housing body 101. In the above-explained configuration, the plate springs 130, 133 and the stoppers 132, 135 constitute impact absorbing means

In the following there will be explained the function of the electric power steering device 100 shown in Fig. 1. By a steering torque entered from unrepresented steering wheel, the input shaft 111 rotates to transmit the torque to the rack shaft 112. The torque detected by the torque detecting device 113 is transmitted to the unrepresented detecting circuit and is compared with a predetermined value. If the detected torque exceeds the predetermined value, there is required the auxiliary steering force, and a drive instruction is released to activate the electric motor 114. Said electric motor 114, driven by the drive instruction rotates the input shaft 111 through the unrepresented reducing mechanism, thereby axially displacing the rack shaft 112. If the torque detected by the torque detecting device 113 is less than the predetermined value, the motor 114 is not activated since the auxiliary steering force is not required.

The rack shaft 112 cannot move infinitely but reaches the stroke end of the reciprocating motion after the movement of a predetermined amount to the right or to the left. In the prior art, the ball joint impinges on a metal ring provided on the rack column

and the housing at such stroke end, thereby inhibiting further movement of the rack shaft. In such configuration, the power transmission system does not incur a material damage when the rack shaft 112 reaches the stroke end with a speed induced by the manual steering.

However, a wheel of the vehicle may get on a curbstone on the wheels of the vehicle may be moved vigorously in the maintenance work. In such a case, a rack shaft moves at a high speed and collide with the stroke end, whereby the motor, which has been rotating with a speed, faster by the reducing ratio, is suddenly stopped and the impact force resulting from the inertia of the motor is applied to the reducing mechanism to deteriorate the function of the bears and bearings.

In such case, in the electric power steering device of the present embodiment, upon collision of the plate spring 130 or 133 and the stopper 132 or 135 at the stroke end, said plate spring is elastically deformed to relax the impact force at such collision, whereby the generation of the impact force in the power transmission system can be prevented.

The present invention has been explained by an embodiment, but the present invention is not limited to such embodiment and is subject to suitable modifications and variations. For example, the plate spring 130 or 133 may be replaced by a coil spring or

simple plate spring, or even by an annular rubber bushing.

As explained in the foregoing, the electric power steering device of the present invention can prevent the deterioration in the function of the power transmission system, as the impact absorbing means provided between the housing and the output shaft and adapted to be pressed and deformed between said housing and said output shaft at the stroke end of the reciprocating motion of the output shaft can sufficiently absorb the impact force generated in the output shaft by the deformation of the impact absorbing means, at the arrival of the output shaft at the stroke end, even in the electric motor rotates at a high speed toward the stroke end of the reciprocating motion of the output shaft.

WHAT IS CLAIMED IS:

1. An electric power steering device provided with a housing; a motor mounted on said housing and having a rotary shaft; an output shaft capable of reciprocating motion within a range limited by said housing, for steering wheels; an input shaft connected to a steering wheel; and power transmission means for connecting said input shaft and said output shaft and adapted to receive an auxiliary steering force from the rotary shaft of said motor, comprising:

impact absorbing means provided between said housing and said output shaft and adapted to be pressed and deformed between said housing and said output shaft at an end of the reciprocating motion of said output shaft, thereby absorbing the impact force generated at the arrival of the moving output shaft at the end of the reciprocating motion.

2. An electric power steering device according to claim 1, wherein said impact absorbing means includes a stopper provided on said housing, and a plate spring provided on said output shaft and integrally moving therewith.

3. A steering device having a housing, an output shaft adapted for reciprocating movement relative to said housing and impact absorbing means for absorbing an impact force between said output shaft and said housing by deformation at the limits of said movement.

4. A steering device substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

Application No: GB 9512668.6
Claims searched: 1 to 4

Examiner: John Twin
Date of search: 30 August 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): B7H (HFC, HFF, HHT)

Int Cl (Ed.6): B62D 3/12, 5/04, 5/22

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US4709591	(Jidosha Kiki) - whole document	1,3
X	US4479400	(ZF) - see eg damping members 22,23	1,3
X	US4428450	(GM) - see eg cushions 78,80	1,3
X	US4187736	(ZF) - see eg dished springs 9	1,3
X	US3951045	(GM) - see eg bumper 80	1,3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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